Unconventional Designs Table of Comparison

(It is assumed that the Peak-Hour traffic volumes for the mainline through-movement are heavy in order to consider any unconventional design)

Alternative Conventional Design	**Applicable *Mainline* traffic volumes**	***Cross-street* left-turn traffic volumes**	***Cross-street* thru-traffic volumes**
Continuous Flow	moderate to heavy left turns	moderate to heavy	moderate to heavy
Paired Intersections	light to moderate left turns	light to moderate	light to moderate
Median U-Turn	light to moderate left turns	light to moderate	moderate to heavy
Superstreet	moderate to heavy left turns	light to moderate	light to moderate
Jughandle	light to moderate left turns	light to moderate	moderate to heavy thru-traffic
*** Continuous T-Flow**	heavy thru-traffic	moderate to heavy left turns	N/A

* Only applies to a T-intersection

It is important to note that when comparing the different unconventional intersection designs to each other that the primary goal of these designs is to provide the largest portion of the signal cycle to the green-time for the mainline through-movement. The most effective and efficient results are a function of both the increased capacity and the monetary costs (constructions and right of way) to accomplish the above mentioned goal.

The unconventional intersection designs that can utilize the existing right of way to a maximum are usually the most cost effective. For example the designs that can use the existing median (where the median is wide enough) for proposed turn lanes and can also incorporate existing deceleration/right turn lanes (by extending them) into the new design. The unconventional designs which best meet these criteria are the Median U-turn and Superstreet intersection designs.

Alternate Grade-Separated Designs

- Tight Diamond grade-separated Interchange

Description:

This is a grade-separated diamond interchange utilizing exit and entrance ramps to provide free-flow for the through traffic on the major roadway. The ramps are located parallel and as close as possible to the major roadway's outside shoulder, usually incorporating retaining walls in lieu of fill slopes. The ramp terminal intersections at the cross-street are spaced closely together (less than 400 ft) and these two cross-street/ramp signalized intersections are coordinated using phasing patterns to eliminate storage lanes on the bridge.

Advantages:

A grade-separated interchange design decreases significantly the number of collisions involving the major roadway through traffic.

This design could reduce the number of cross street accidents that occur between the ramps terminals.

The Tight Diamond requires minimal right-of-way as compared to conventional grade-separated interchanges and unconventional at-grade intersection designs that incorporate ramps.

This design is compatible with frontage road connections.

The diamond interchange design has major roadway traffic exiting and entering on the right which is normal driver expectations.

Disadvantages:

If the cross street has heavy traffic, the close intersection spacing could adversely affect the progression of enhanced signals coordination on the cross-street.

This type of design has the possibility for a minor increase in merge/diverge collisions.

This design has much more construction cost than the at-grade intersection designs because of the cross-street bridge and ramp retaining walls.

This design uses more right of way than the at-grade unconventional intersection designs that utilize u-turn median crossovers for left turns.

Cost:

$ 15,000,000

SR 400 Applications:

If it is determined that SR 400 is to be grade-separated facility then a Tight diamond interchange design with retaining walls would be the most economical design because on the savings in commercial right of way.

Other Features:

It is believed that the Tight Diamond interchange design originated from old standard diamond interchanges that did not operate and were "redesigned" to operate as a four-phased Tight Diamond interchange.

Tight Diamond interchanges are typically used in heavily populated suburban or urban areas.

Research comparing the operational efficiency of the Tight Diamond and the Single Point Urban interchanges, revealed that the signals within the Tight Diamond can optimized at a shorter cycle length, which result in decreased delays and shorter queues

Locations in Georgia:

Tight Diamond: 1. Cumberland Pkwy at I-75, 2. Old Milton Pkwy at GA 400

Alternate Intersection Designs

- Paired-Intersections

Description:

The philosophy of the paired intersection design is the separation of left turns to allow more emphasis of through-traffic movements.
The Paired Intersection design prohibits left turn movements from the major roadway onto a main crossroad (only through and right turn traffic are allowed along the major roadway) and then prohibits left turns from the cross streets that are located before and after the main crossroad intersection along the major roadway corridor. A system of two-way "offset" roads, which are parallel to the major roadway, are required in this design to provide adequate circulation and to allow proper turning movement access to the cross-streets.

Advantages:

The main crossroad operates under a two-phase signal which allows more green time for the heavy major roadway through movement.

Less construction cost than a grade-separated interchange.

Less R/W right along the mainline roadway than the intersection designs that utilize "ramps" for turning movements.

This concept if designed properly could provide adequate access to surrounding businesses by using a system of parallel "offset" roadways and cross streets.

This design separates and reduces points of conflict along the major roadway.

Disadvantages:

There would be additional R/W requirements for the parallel "offset" roadway system. However, a case could be presented to developers and local governments for them to participant in the "offset" roadways in lieu of other designs that would impact their access more severely.

As do most unconventional designs the Paired Intersection could initially confuse vehicles that are making turning movements.

There would be increased travel time and distances for some left-turning vehicles and cross street through traffic.

Longer time/delay for pedestrian traffic crossing the major roadway.

Costs:

Most of the cost would be for the cross streets (if the didn't already exist) and the parallel "offset" roadways system.

Locations:

This design was developed in North Carolina pertaining to conceptional work on US 70. There are no full-designed Pared- Intersections in the U.S.A., however the principles of this design have been used by restricting turning movements and using adjacent streets to circulate local traffic.

SR 400 Applications:

It is recommended that the design hourly volumes for each at-grade intersection be analyzed for the left turn volumes to identify the intersections that would be candidates for the Paired-Intersections design.

Other information/features:

There is precedent of Traffic Departments prohibiting certain turning movements, especially in urban situations, to facilitate through-traffic movements with minimum delay along the mainline.

Alternate Intersection Designs

- Superstreet-Intersection

Description:

The Superstreet design is a variation of the Median U-turn Crossover design which diverts the cross street conflicting traffic (through and left turn movements) to the mainline median u-turn crossovers. This change in conventional intersection traffic patterns eliminates the requirement for a separate signal phase at the major roadway/cross street intersection to address the cross street traffic. All the mainline major roadway traffic movements, including left turns, are allowed at the main intersection.

Advantages:

The main crossroad operates under a two-phase signal which allows more green time and less delay for the heavy major roadway through and left-turn movements.

Less construction cost than a grade-separated interchange.

Less R/W required along the mainline roadway than for intersection designs that utilize "ramps" for turning movements.

Pedestrian traffic could cross the mainline diagonally without any turning traffic conflicts.

This design separates and reduces points of conflict along the major roadway.

Disadvantages:

There would be increased travel time and distance for ***both*** the cross street's through and left-turning traffic movements.

Depending on existing median width this design could require additional R/W along the mainline (for u-turns) as compared to a conventional at-grade intersection.

This design could be confusing to driver's expectations of conventional intersection cross street traffic maneuvers.

Access to properties affected by extra pavement or "brow" for U-turns

"Unconventional" pedestrian diagonal crossing route.

Costs:

$1,150,000 (estimate assumes that there are existing mainline left-turn lanes)

SR 400 Applications:

Principals of this design would be most applicable where the cross street traffic volumes are not heavy.

Locations:

There is one known application of this design in the U.S.A., which is under construction in North Carolina. However, variations of these principals of this design have been implemented by restricting and removing turning movements at major intersections to other median crossovers.

Other Facts:

Produces most operational benefit and travel time savings when there are heavy through volumes along the mainline and low through traffic volumes along the cross-street

It is important to realize that this design is not applicable for major roadways that have narrow median widths with no available R/W for widening.

Alternate Intersection Designs

- Median U-Turns Intersection Design (Michigan Lefts)

Description:

This design utilizes U-turns to replace the left turn phase by using directional U-turn median crossovers beyond the at-grade signalized intersection. A vehicle traveling on the major roadway desiring to turn left at the minor cross-road would travel through the intersection and enter the first median U-turn crossover, after making the U-turn the vehicle would turn right onto the minor cross-road. Vehicles on the minor cross-road desiring to turn left onto the major roadway would make a right at the intersection approach and then enter the median U-turn crossover lane.

Advantages:

Since the left turn phases at the at-grade signalized intersection cross-road intersection are eliminated this ***decreases the travel time*** for the through traffic.

Studies have shown that this intersection design ***is safer*** and has a decrease in turning movement accidents since the left turn conflicts at the cross-road intersection are eliminated.

The additional ***construction cost is relatively small*** as compared to a grade separated "intersection" since the cost for the median U-turn lanes replaces the cost for the eliminated conventional left turn lanes. The additional construction costs would be for longer right turn lanes (to handle traffic that was previously making a left turn), additional signage and signals at the median U-turn crossovers.

The timing of traffic signals can be enhanced along a corridor implementing this intersection design which eliminates the left turn phases on both crossroads. This ***Enhanced Traffic Signal Progression*** maximizes the efficiency of a corridor by minimizing stops and delays, decreasing travel time, reducing emissions and reducing accident rates.

When this intersection design is used on both crossroads it provides ***two options for "turning left"***. The first option is to past through the intersection and utilize the median U-turn to approach the crossroad from the opposite direction and then turn right onto the crossroad. Then second option is to turn right onto the crossroad and then use the median U-turn to complete the left turn. This allows for alternate routes to turn left when there are traffic accidents and at certain times to avoid signal delays.

(Median U-Turns Intersection Design continued)

Pedestrian crossing is facilitated since the conflicting left turn movement is eliminated and only the through traffic and right turn movements have to occur.

Disadvantages:

Short weaving sections for certain vehicles that enter and exit the median U-turns. However the weaving problem could be avoided by providing signals at the median U-turns and implementing **no** right turn on red.

Drivers will have to ***become familiar with the "unconventional" design***. For intersections that would **not** provide a median U-turn on the minor road it could be confusing that they need **to** be in the right turn lane. However, proper signage in advance of the intersection can resolve this problem.

Additional construction cost will be required on high traffic roadways (such as SR 400) to provide for traffic signals at the median U-turn crossovers to allow for a U-turn protective phase. However some of this additional cost will be offset since the signalization of the crossroad intersection will be simpler due to the elimination of the left turn phases.

Additional right of way could be required where the major roadway median is narrow in order to provide for additional roadway width to accommodate U-turns for large vehicles. This extra pavement or "brow" for U-turns would also affect accessibility to properties.

Even though this design benefits traffic flow during high volume periods (especially peak hour), it ***delays lefts turns movements during non-peak traffic periods*** by left turns at the crossroads intersection.

Description of the use on SR 400 and other options:

Studies and research show that the Median U-turn Design is efficient and safe while moving heavy volumes of traffic through at-grade intersections. The Michigan DOT reports that sections of eight-lane arterials utilizing the Median U-Turns Intersection Design have handled traffic volumes of 100,000 vpd with total intersection entry volumes as high as 150,000 vpd. It is also reported that some of these intersections may experience congestion during peak periods, however total intersection failure is rare.

It is important to note that based on studies the Median U-turn Design produces the most operational benefit and travel time savings when the left turn movements are moderate to low volumes.

Based on the findings mentioned above it is recommended that the DHV for each at-grade intersection be analyzed for the left turn volumes to determine which intersections would be candidates for the Median U-turn design.

Approximate Cost: (for partial Median U-turn design with median u-turn crossovers only on the major roadway)

$910,000 (includes two signals for protected u-turn movements)

Other locations in Georgia where this alternative design is been used:

Not any in Georgia at this time, however other states have used this design ... most notable is the Michigan DOT.

Alternate Intersection Designs

- Continuous Green-T (Florida-T)

Description:

The Continuous Green-T design is only applicable for T-intersections. This design uses an acceleration/merge lane in the median of the major roadway to accept left turn movements from the cross-street which allows for a free-flow through operation in one direction on the major roadway. Since this design can reduce the number of signal controlled traffic movements, by using free-flow right turns lanes on all the approaches and acceleration/merge lanes the left turn movements from the cross-street, the intersection signalization can operate with only three phases.

Advantages:

This design decreases the delay times at the intersection when compared to conventional intersection design.

This design provides a true continuous free-flow movement for one direction of through-traffic on the major roadway.

The right of way requirements are less than the unconventional intersection designs that incorporate separate ramps to handle turning movements.

Disadvantages:

This implementation of this design is restricted to only T-intersection.

The left turns entering into the mainline on the left creates more merging and weaving maneuvers.

To function properly this design cannot allow any driveway access onto the major roadway in the vicinity of the T-intersection.

Because of the continuous mainline through-traffic movement (in one direction) a signalized pedestrian crossing cannot be provided.

Construction Cost:

$580,000 (if existing signal is reused than cost would be less)

SR 400 Applications:

The benefits of this design are limited to only T-intersections and most applicable when the cross-street left-turn traffic volumes are low to moderate; the mainline through volumes are heavy; number of pedestrians crossing the mainline are low; and the driveway access to the major roadway at the T intersection can be restricted.

Locations:

The most prominent use of the Continuous Green-T Intersection design is in Florida.

Alternate Intersection Designs

- Jughandle Intersection

Description: (two variations)

The Jughandle design uses ramps ***in advance of*** the major intersection to exit all mainline turning movements from the right side of the major roadway. This design removes the mainline left turn movement from occurring at the cross-street major intersection. The major roadway left turns are now made at stop-controlled ramp intersections on the cross-street. The minor cross-street left turn movements are still permitted at the major intersection.
In the second variation of the Jughandle design, right-exit loop ramps ***are placed beyond*** the major intersection to handle heavy left turn volumes onto the cross-street. This design utilizes two right turns to avoid a conflicting left turn from occurring at the major intersection. This same loop ramp design could also be implemented for cross-streets with heavy left turn movements.

Advantages:

The main crossroad operates under a two-phase signal which allows more green time for the heavy major roadway through movement.

Less construction cost than a grade-separated interchange.

This design separates and reduces points of conflict along the major roadway.

Typically requires less right of way acquisition than a grade-separated interchange design.

This design can be incorporated into major roadways with narrow medians since left turn lanes are not in the median.

Disadvantages:

Unconventional turning maneuvers could possibility cause driver confusion.

Increase in travel distance and delay for left turns from the major roadway onto the cross street.

This design enhances the progression of traffic signals for the mainline traffic corridor.

Ramp terminals create additional pedestrian crossings.

This design is not desirable for cross streets with heavy through volumes since queues of the cross street vehicles could block the ramp terminal.

This design requires additional right-of-way at intersections and lack of access to both cross-streets for properties adjacent to the ramps as compared to conventional intersection design.

Usually increases construction cost for ramps as compared to designs incorporating left-turns and u-turns in an existing wide median.

Approximate Construction Cost:
(Construction costs for Jughandle ramps in two mainline quadrants and signalized ramp/cross street intersection)
$ 1,000,000 (higher design speed loop ramps could be more expensive since ramp widths will be wider than normal widths)

SR 400 Applications:

The Jughandle intersection design with ramps which exit prior to the intersection and still require left turns at the cross-street operate most effectively with low to moderate mainline left-turns volumes

The Jughandle intersection design with loop ramps handles moderate left-turn volumes from the main thoroughfare very effectively based solely on an operational stand point.

It is recommended that the DHV for each at-grade intersection be analyzed for the left turn volumes to determine which intersections would be candidates for the Jughandle intersection design.

Location:

The Jughandle/ramps intersection design has been utilized to move heavy mainline through volumes by the New Jersey DOT for many years on US 1 and other locations.

Other applications of this design have been implemented in Florida, Hawaii, Missouri, as well as throughout the northeastern USA.

In Georgia ???

Other:

In New Jersey the circumscribed area (between ramps and cross-streets) is typically preserved and landscaped by area businesses through the state-sponsored "Adopt-a-Jughandle" program

Alternate Intersection Designs

➢ Single Point Urban (grade-separated) Interchange (SPUI)

Description:

The SPUI, as all grade-separated interchanges do, provides free flow for the through movements on the major roadway. All the major highway and cross-street turning movements are handled by locating the ramp terminals close enough so they may function as a "single" signalized intersection that is separated grade from the major highway through traffic. This "single" intersection can be located either under or over the major thoroughfare highway. All right turn movements are accommodated by unsignalized turning lanes separated from the main intersection.

Advantages:

A single, signalized intersection on the cross-street improves the progression of traffic on the cross-street as compared to a conventional Diamond interchange which has signals at both ramp terminals.

The SPUI provides longer turning radii and higher speed design for the left-turn maneuvers, which increase the intersection's flow rates and capacity. Under the best geometric situations the left turn rates can approach those of through movements.

When comparing different types of grade-separated interchanges the SPUI is less disruptive in highly commercial developmental areas since it can be constructed in limited rights-of-way.

Since the opposing left turns can occur during the same phase the SPUI reduces the signalization to three phases.

Disadvantages include:

Construction costs are higher mainly because of a longer or wider bridge depending on whether the major roadway passes over or under the cross-street.

Requires increase in signage and markings and possibly illumination to guide the turning movements all the way through the intersection and into the proper cross-street lane.

Pedestrians crossing the intersection have a difficult time since opposing left turns occurred at the same time.

A protected pedestrian phase would reduce intersection operational efficiency and traffic capacity.

Construction Costs:

$16,000,000 (exact costs would vary with the width of the expressway or cross-street to bridge over, and number of required ramp and cross-street lanes)

SR 400 Applications:

SPUI should be considered for design where the mainline through-traffic volumes are heavy enough to justify grade separating a cross-street intersection and also heavy cross-street volumes exiting and entering the major roadway. However each proposed grade separation would need to be studied and traffic modeled to determine if the SPUI was the most appropriate design.

Locations in Georgia:

Macon, I-185 at Macon Road/SR 22

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Locations in Georgia:

Macon, I-185 at Macon Road/SR 22
Atlanta, SR 141/Peachtree Industrial Blvd at SR 140/Jimmy Carter, and SR 400 at SR 141/Lennox Road in Buckhead

Alternate Intersection Designs

➢ Continuous Flow Intersection (CFI)

Description:

The left turn phase is replaced by turning left prior to the major intersection (at-grade signalized) at a signalized median "crossover" intersection and then move into separated lanes with opposing through traffic now to the right of the turning vehicles. The protected left turns at the median crossovers are made simultaneously with the through movements, permitting a simple two-phase intersection signal control.

Advantages:

Removing the protective left turns eliminates multi signal phase operations and provides ***more green time for the major roadway through movement.***

This design has ***less construction costs*** and construction time than a grade-separated interchange design.

Removes number of conflict points from major intersections.

Typically requires less right of way acquisition than a grade-separated interchange design.

When the separate left-turn and through movement signals are sequenced properly the pedestrians can cross without any conflicting traffic.

Provides more roadway capacity as compared to conventional at-grade intersections

Disadvantages:

Left turns require more delay and stops to complete this maneuver.

This intersection design requires more right of way as compared to other unconventional at-grade intersection designs.

Two-phase pedestrian crossing delays for both the mainline through movements and the separate left turn "ramps".

This design could cause driver confusion when making unconventional left turns by using two maneuvers, one maneuver made before the intersection and second with opposing traffic to the driver's right. Both these maneuvers violate the driver's "normal" expectancies to negotiate a left turn.

The left-turn "ramps" would restrict the access from the adjacent properties to the mainline roadway.

Existing Locations:

There are several full Continuous Flow intersections (left-turn ramps in all four quadrants) under construction in Louisiana.
There are two T-intersections (left-turn ramps in a single quadrant) of the Continuous Flow intersections which exist in Maryland and New York.
There are numerous full CFI intersections that exist in Brazil, Chile and Mexico.

Cost:

$ 1,500,000 (does not include R/W) (reflects partial CFI design in the two quadrants of the major roadway approaches- includes two signals for protected u-turn movements)

SR 400 Applications:

It is recommended that the design hourly volumes for each at-grade intersection be analyzed for the left turn volumes to identify the intersections that would be candidates for the CFI design.

The CFI design produces most operational benefit and travel time savings when left-turn movements are heavy and require a protected phase.

If the minor cross-street has low left turn volumes then these left turns may be permitted at the major intersection.

At the main intersection, previously conflicting through- and left-turn movements can operate simultaneously as protected movements under the same signal phase.

Other comments:

The description "Continuous Flow" for this intersection design is not entirely accurate, since traffic is required to stop at signals at the intersection. However, the CFI design separates left-turn maneuvers from conflicting through-movements, thus allowing left-turns to be made during the same phase as the opposing through-movements.

http://www.tfhrc.gov/safety/pubs/04091/10.htm#1023

Managed Lanes

- Reversible Lanes (barrier separated "express lanes")

Description:

Reversible lane design consists of one or multiple lanes located in the median of a major highway with barrier separation from the adjacent general purpose lanes. When there are multiple reversible lanes the desirable typical section is to have 10 ft shoulders on both sides of the reversible lanes.
Under this design the barrier separated "express lanes" (reversible lanes) would be grade-separated at every cross-street.

Advantages:

Construction costs would be much less as compared to a continuous elevated bridge typical section.

This design is more cost effective since the same reversible lanes can be used for the peak direction in the AM and PM.

This design would allow a free-flow ("expressway") through traffic movement along the major highway corridor using this typical section.

This design eliminates points of conflicts for the "express" through traffic.

Disadvantages:

Since the express lanes are barrier separated from the general purpose lanes, they would have a limited number of access points.

This design does not address any increase in traffic volumes for the direction of travel opposite the reversible lanes.

The daily operation of the reversible lanes can be time consuming and complicated.

The additional construction costs for grade-separations/bridges at each cross-street.

Construction costs:

$ 8,000,000/ mile for two reversible lanes in the median at grade with the general purpose lanes

$ 5,000,000/mile for one reversible lane in the median at grade with the general purpose lanes

Each grade separation would be an additional $5,000,000 for bridge and retaining walls for the express lanes to pass over the cross-street.

SR 400 Applications:

For the section of SR 400 (south of SR 53) where the existing median is 64 ft wide, it would be feasible to build two reversible lanes without widening SR 400 (see attached typical section).

For the section of SR 400 (north of SR 53) where the existing median is 40 ft wide, it would be feasible to build only a single reversible lane without widening SR 400 (see attached typical section). If it was desirable to build two reversible lanes where the existing median is only 40 ft wide, then SR 400 would have to be widened 7 ft in each direction for a total of 14 ft (see attached typical section).

Other Features:

The entrance and exit ramps access to the reversible lanes is allowed by utilizing swing gates and changeable message signs to tell drivers of the current direction of travel and traffic conditions.

Since reversible lanes "ignore" traffic volumes in the opposite direction they usually are considered a viable solution only where the directional distribution factor is imbalanced in one of the direction.